FIELD ARTILLERY SUPPORT FOR THE BRIGADE'S FIGHT

A MONOGRAPH
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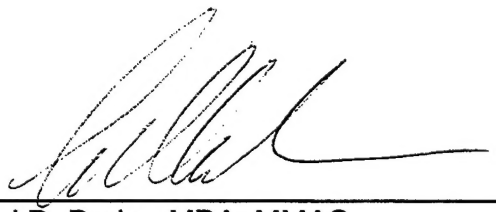

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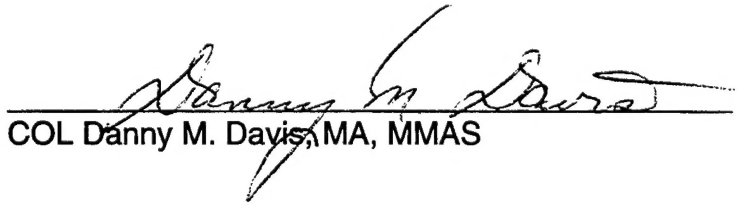

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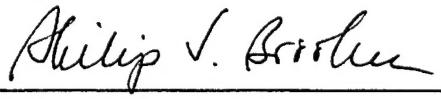

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ABSTRACT

FIELD ARTILLERY SUPPORT FOR THE BRIGADE'S FIGHT by MAJ Jeffrey A. Springman, USA, 43 pages.

Under current fielding plans two FA brigades will reinforce committed divisions. Each brigade consists of two MLRS battalions (3X9) and one CRUSADER/PALADIN battalion (155mm, SP, 3X6). A division will be able to use its three cannon battalions as direct support with two 155mm battalions from corps as reinforcing artillery. If all three brigades are committed, at least one brigade will not have reinforcing cannon artillery. While MLRS might be used as reinforcing, its different characteristics render it inappropriate for some close support missions.

Compared to the end of the Cold War and Gulf War, there is more MLRS available to support the division and corps fights but less cannon artillery to support the brigade's fight. The greater capabilities of PALADIN and CRUSADER, along with more assets supporting the deep fight, will change the amount of fires available. Under these conditions, will the brigade commander have more or less field artillery available and what support will that artillery provide? Several classified studies and scenarios determine that overall the field artillery support improves. But the Field Artillery community must be able to tell brigade commanders what it will bring to the battlefield in simple, unclassified terms.

This monograph attempts to answer these questions by examining current and future doctrine, field artillery organizations, equipment and capabilities of systems, and historical record. The monograph determines that brigades supported by CRUSADER battalions will receive more artillery support. However, there are ocassions when the twenty-four howitzer M109A5 battalion provides more support than an eighteen howitzer PALADIN battalion.

TABLE OF CONTENTS

I. INTRODUCTION

The final draft of FM 6-20, Doctrine for Fire Support, states "(t)he mission of the field artillery is to destroy, neutralize, suppress, or harass the enemy by cannon, rocket, and missile fire and to help integrate all fire support into combined arms operations."[1] The only change from the May 1988 edition, FM 6-20, Fire Support in the AirLand Battle, is the addition of the word "harass." The 1988 version had made no changes to the mission statement from the December 1984 edition. Essentially, the mission of the Field Artillery has not changed from the Cold War to the present. The mission is not expected to change in the future. At the end of 1996, MG Rigby, then Chief of Field Artillery, wrote, "As we move toward Army XXI and the Army After Next, it's safe to anticipate that the traditional roles of the Field Artillery will remain the same. Providing improved close support, battlefield interdiction and counterfire will continue to dominate missions. It isn't a question of whether or not the requirements for these missions will exist but rather of how we will accomplish them."[2] The Field Artillery, like the rest of the Army, has to accomplish its mission while downsizing, reorganizing, fielding, and developing new equipment.

Although the Field Artillery is downsizing, one of the effects of downsizing overall is to place a greater burden on the Field Artillery. Maneuver will be more dispersed and come together only for short periods of time. If the fog of war delays a decision to mass, maneuver units may become decisively engaged without being able to support each other. The committed maneuver units will

rely more on artillery and other means of fire support. Division and corps commanders will use field artillery to participate in deep attacks to shape the battlefield for the close battle and to defeat the enemy deep. Additionally, the downsizing of maneuver forces requires the supporting field artillery units to provide more responsive and effective fires. For "Operation Desert Storm" five heavy divisions with fifteen brigades (including the "Tiger Brigade", TACON to the Marines) and two heavy ACRs deployed. All were active duty brigades. Currently, there are six heavy divisions, including 2ID in Korea, totaling eighteen brigades and one heavy ACR on active duty. With the possibility of two major regional conflicts (MRC), commanders will rely more on field artillery and other fire support means until heavy reserve component maneuver units arrive. These conditions require the field artillery to provide more support for the close fight and even more for the deep battle to prevent the enemy from bringing all his combat power to the close fight.

While the basic principles of fire support, roles of the field artillery, and fundamentals of organizing field artillery for combat remain true and applicable, the Field Artillery is making a major shift from a predominance of cannon fires to rocket fires. With the advent of new munitions and equipment, the capabilities of the two overlap, but basic differences between the two remain. Specifically, the type of system, rocket or cannon, will often determine the tactical mission assigned. Field artillery support for the heavy divisions is focused on two systems, 155mm self-propelled howitzers and Multiple Launch Rocket Systems

(MLRS). Cannon battalions will remain the backbone of support to maneuver brigades. While, division and corps support missions will be performed almost exclusively by MLRS that are Army Tactical Missile System (ATACMS) capable.

Despite force downsizing[3], the number of MLRS available to the force is increasing. The field artillery support a heavy division or corps can expect to receive will, undoubtedly, prove to be more lethal than during the Gulf War or any time prior. Under the fielding plan, a heavy division commander will have tremendous field artillery assets available. The commander will have his division artillery (DIVARTY) and two field artillery brigades from corps artillery. The corps will maintain one field artillery brigade (81 MLRS) in general support to the corps. The division will have five battalions of MLRS and five cannon battalions in support. The relatively large number of MLRS will increase the amount of firepower available to the division and corps. However, there is a decrease in the total number of cannon to support all levels of maneuver. The field artillery support available is shifting from cannon to rocket and missile fires. Additionally, the majority of field artillery support, even for active divisions, will come from the National Guard.

Under these conditions, will the brigade commander have more or less field artillery available and what support will that artillery provide? Several classified studies and scenarios determine that overall the field artillery support improves. But the Field Artillery community must be able to tell brigade commanders what it will bring to the battlefield in simple, unclassified terms. The

best means to answer these questions is to study current and future doctrine, Field Artillery organizations, the historical record and capabilities of systems.

II. OBJECTIVE FOR FIELD ARTILLERY SUPPORT

The Army's six heavy divisions are based on the Army of Excellence (AOE) design. The equipping, staffing, and structure of these divisions will change based on requirements and constraints as the world enters the twenty-first century. The decision for the final divisional design has not been made. However, the approved interim design for the modernized heavy division consists of three ground maneuver brigades, cavalry squadron, aviation brigade, division support command (DISCOM), engineer brigade, signal battalion, military intelligence battalion (MI), and air defense battalion. The division has a brigade sized unit (DIVARTY) to provide field artillery support and coordinate fire support. It is doubtful that the field artillery structure for the division will change since these changes were being implemented prior to the division redesign based on the support required for a three ground maneuver brigade division.

The DIVARTY of the modernized heavy division consists of three 155mm self-propelled howitzer battalions, a command and attack battalion, and the DIVARTY headquarters. The self-propelled howitzer battalions contain three firing batteries of six howitzers each. The objective is to equip the battalions with CRUSADER as the howitzer becomes operational. In the interim, the battalions will be equipped with PALADIN, M109A6.

The 155mm battalions in AOE divisions contain three batteries of eight howitzers each for a total of twenty-four howitzers per battalion. The howitzers are either M109A5 or PALADIN. Some units have the older M109A4 but will be upgraded. The command and attack battalion consists of two MLRS batteries of nine launchers each and the target acquisition battery (TAB) of three Q-36 radars and two Q-37 radars.

The objective is that the modernized heavy division DIVARTY will be reinforced by two corps artillery brigades. The reinforcing brigades contain two MLRS battalions and one 155mm cannon battalion. The MLRS battalions will have three firing batteries of nine launchers each, for a total of twenty-seven launchers per battalion. The cannon battalion will be equipped with either CRUSADER or PALADIN. Until CRUSADER is fielded, PALADIN will be fielded in lieu of CRUSADER. Until PALADIN has been fielded to all active 155mm self-propelled battalions and to the early deploying reserve component battalions, M109A5 or M109A4 will be used. Eventually, the remaining National Guard 155mm self-propelled battalions will field the M109A5 in six howitzer batteries. The corps self-propelled howitzer battalion has three firing batteries of six howitzers each for a total of eighteen per battalion. The two reinforcing brigades give the division an additional 36 cannon and 108 MLRS for a total of 90 cannon and 126 MLRS. Currently, only three active duty Field Artillery brigades are structured with two MLRS battalions and one 155mm howitzer battalion.

To field the twelve required brigades, the Field Artillery will rely mainly on the National Guard.[4] This reliance is not a recent development predicated by the restructuring since the Field Artillery has relied considerably on the reserves in the past. Two reserve component Field Artillery brigades participated in Operation Desert Storm.

The fielding objective calls for each heavy corps to retain one FA brigade, consisting of three MLRS battalions, in support of the corps. This will provide the corps with 81 launchers. While all launchers are ATACMS capable, these units will probably fire the majority of the missiles; launchers supporting divisions will be limited to the shorter range munitions. Currently, the Army has only one of the two brigades required for corps support on active duty. There are brigades in the National Guard that could be augmented to three MLRS battalions.

The objective force structure began to take shape well before the division redesign study. The first major effort to determine the field artillery force structure requirements after the Vietnam War was Legal Mix V. The Legal Mix V study report was published in several classified volumes throughout 1977. Most of the volumes were declassified in 1983. The purpose of the study was to determine the support requirements for a committed division during three time periods. The periods were 1976, 1981, and 1986. The study can be described as determining where the Field Artillery was in 1976, where it needed to go to fight and defeat the Soviets in Europe in 1986, and the best interim organization for 1981. There was some consideration made of the Middle East and other

areas, but Europe was the main focus. The two major findings from Legal Mix V were the demonstrated need for a general support rocket system (MLRS) and twenty-four howitzer artillery battalions. The study called for batteries of six launchers for MLRS. The study also validated the FIST concept, showed a continued need for the 8" howitzer, and demonstrated the requirement for the FIREFINDER radar fielding of three Q-36 and two Q-37 radars in a DIVARTY. The unconstrained division mix, determined by the study, consisted of seventy-two 30 kilometer range M109 (155mm) family howitzers, thirty-six 8" M110A2 howitzers, and eighteen MLRS launchers. The constrained mix recommended by the study consisted of twenty-four M110A2 howitzers. The artillery support requirements for the division equated to a DIVARTY and a reinforcing corps artillery brigade.

The post-Vietnam heavy division artillery support differed from the conclusions of Legal Mix V. MLRS was fielded in nine launcher batteries, reducing the requirement to two batteries instead of three. All 8" howitzers were moved to corps artillery units and the National Guard. For several reasons, including reliability, the 8" howitzer was eventually replaced in the active component. This venerable weapon will also be replaced in the National Guard. The 8" howitzer's missions have been assumed by either MLRS or 155mm.

In absolute terms, VII Corps met these requirements during Operation Desert Storm in 1991. For its five heavy division equivalents, including the 1st UK Armoured Division, the Corps had over 110 howitzers and over 32 MLRS

launchers per division. Of course, not every division had this much under their control due to task organization and pooling of resources at Corps. However, the numbers from the Legal Mix V study appear to include corps assets in a division's sector but not necessarily under the division's control. The howitzer numbers include 155mm and 8". Taken by itself, there was not sufficient 8" as required by Legal Mix V. Although the study called for a corps artillery brigade headquarters to reinforce each DIVARTY, only four artillery brigade headquarters deployed. This does not appear to have been a problem.

Legal Mix V identified some shortfalls that would continue in the 1986 time frame under the fielding and development plans at that time. The major issue was target acquisition capability more than ten kilometers beyond the front-line. This shortfall is being addressed by technologies such as unmanned aerial vehicles (UAVs), joint surveillance target attack radar system (J-STARS), etc., and addition of the brigade recon troop.

In October 1995, the Army Science Board published a report titled "Innovations in Artillery Force Structure." The study was the result of concerns of division commanders during Operation Desert Storm over a perceived shortage of general support artillery available to the division. Senior leaders were also concerned over availability of field artillery support due to downsizing. The scenarios used for the report were Southwest Asia (SWA) and Northeast Asia (NEA). The focused on corps level decisive operations, defense, and offense. The scenarios were developed at Fort Leavenworth by the Scenario and

Wargaming Center of the TRADOC Analysis Center (TRAC) and are classified. Additionally, evidence from Operation Desert Storm was used for the study. The Science Board made several recommendations that included increasing the reinforcing corps artillery brigade support for a division from one brigade to two, adding a second MLRS battery to the division's structure, and creating a fourth 155mm battalion within the division by decreasing divisional batteries from eight to six howitzers.

The total number of Field Artillery units required by the total force was greater than future plans had allocated. Therefore the report recommended restructuring National Guard units to meet the support requirements. The report also recognized that the National Guard units would have to deploy in the event of a major regional conflict (MRC). The changes recommended in the study are the current objective structure, with one exception. The three divisional 155mm battalions are being reduced to eighteen howitzers but the fourth 155mm battalion will not be added to the division's structure.

The division must organize its organic and reinforcing artillery assets to provide adequate, responsive, and effective fires for committed units and the force as a whole. By assigning tactical missions to its artillery assets, division determines the amounts of support units and areas will receive, and the amount of control placed on artillery fires.

III. FIELD ARTILLERY ORGANIZATION FOR COMBAT

Throughout history, field artillery organization for combat has been a struggle to provide adequate fires and meet two conflicting requirements. The conflicting requirements are effectiveness and responsiveness. Generally, if the control of fires is centralized, the fires are more effective. However, artillery fires are more responsive when operating under decentralized control.

In the extreme, a force commander, in this case a division or corps commander, who centralized all fires could influence the battle favorably for the force as a whole more quickly with fires than by moving ground maneuver forces. However, some committed units would not receive needed support and assets could be wasted. The firing of all units may be too much support at the point of attack, wasting munitions. The munitions fired may continue to damage already destroyed targets. Or, fire units remain idle because they are not needed for the desired effects or can not range the target. As a result, the friendly force may suffer greater casualties and be unable to protect itself.

With decentralized fires, the brigade commander can rapidly support committed units with artillery and engage the enemy at ranges greater than direct fire. If all field artillery assets were decentralized, brigade commanders would receive very responsive fires but again assets would be wasted. The force commander would not be able to quickly influence the battle and heavily committed maneuver units could require more support while less committed units would not require all their support. Because of the conflicting requirements,

effectiveness and responsiveness, the Field Artillery developed two general missions; one for supporting the force as a whole and one for supporting committed units.

While no commander would go to either extreme, there have been trends through history to lean towards one or the other. At the start of the American Civil War, typically a brigade would have a six gun battery in support. Very little artillery was left to support the force as a whole. While it would seem that committed brigades had adequate support, in reality artillery was left idle in some areas while heavily committed units did not receive adequate support. At the battle of Chancellorrsville, several Union batteries ran out of ammunition and were not replaced because of a lack of sufficient artillery in the Artillery Reserve (artillery not committed to a maneuver unit) and MG Hooker's refusal to give BG Hunt, Chief of Artillery, authority to move batteries from support of uncommitted maneuver units. Hooker's refusal to give Hunt the authority caused further problems by creating greater enmity between the two officers.

The Southern artillery had been reorganized and centralized the previous winter. The bulk of Southern artillery was under corps control, with the remainder in the Artillery Reserve. The Southern Chief of Artillery had authority to move artillery from uncommitted forces. The bulk of Northern artillery was under division control with the remainder in the Artillery Reserve; corps had none under its direct control. While this was not the reason for the North's defeat, it was a cause for infantry to be unsupported and to suffer greater casualties.

Immediately after the battle, Hooker reorganized the artillery along the lines of Hunt's recommendation. The bulk of the artillery was placed under division control with the remainder in the now doubled Artillery Reserve. Although Hunt and Hooker did not know it at the time, the new structure closely matched the new Southern structure. It was with this new organization that Meade fought Gettysburg.

After the Civil War and through Vietnam, artillery support continued to develop and provide more effective and responsive fires. Some of the changes were technological and some organizational. As permanent divisions were formed, division artilleries were formed to support committed units. Corps and army artillery units were formed to provide counterfire and a pool of resources to reinforce divisional artillery, and allow the force commander to influence the battle quickly. Fire direction centers were formed to rapidly mass the fires from battery to corps level. The artillery was motorized and provided with radios. These changes were made to provide adequate, effective, and responsive fires.

While technology, such as radios, computers, etc., can alleviate some of the struggle between effectiveness and responsiveness, the Field Artillery has developed four standard tactical missions for artillery units to help maximize responsiveness and effectiveness. The missions are direct support (DS), reinforcing (R), general support reinforcing (GSR), and general support (GS).

Direct Support. DS is the most decentralized and most responsive tactical mission. The DS battalion provides fires for the supported unit first, then itself,

and finally the force artillery headquarters (DIVARTY or corps artillery). A field artillery battalion assigned a DS mission can be DS to only one maneuver unit and a maneuver unit can have only one field artillery unit DS. Typically an artillery battalion is DS to a maneuver brigade. Divisional howitzer battalions are designed for the DS mission. The battalions are habitually associated with the supported brigade and have organic observers that are attached to the brigade when deployed. As long as the observers from the habitually associated battalion deploy with the brigade, another battalion could conceivably provide direct support fires to the brigade. The commander of the DS battalion is the brigade's Fire Support Coordinator (FSCOORD) and assists in planning the brigade's fires. The battalion coordinates with the supported unit for terrain that allows the best fire support and supports the scheme of maneuver.

Reinforcing. Reinforcing battalions augment the fires of a DS battalion. A reinforcing battalion can only reinforce one battalion. However, one DS battalion can be reinforced by one or more battalions. Typically, a corps artillery 155mm battalion is assigned a reinforcing mission. However, a divisional battalion may be assigned a reinforcing mission if its habitually associated brigade is uncommitted or is the reserve. Reinforcing battalions answer calls for fire from the reinforced battalion, its own assets, and the force artillery headquarters, in order. It is positioned by and provides liaison to the reinforced battalion. It may act as the DS battalion and control fires while the DS battalion headquarters is moving.

General Support Reinforcing. GSR battalions provide fires for the force as a whole and augment the fires of a DS battalion when possible. GSR battalions are a combination of centralized and decentralized control but their fires are more centralized than decentralized. Typically, corps or divisional MLRS battalions or batteries and corps 155mm battalions perform GSR missions. The GSR battalion responds to calls for fire from the force artillery headquarters, the reinforced battalion, and its own assets, in order. The force artillery headquarters controls its movement and positioning but the battalion provides liaison with the reinforced battalion. The establishment of communications and liaison with the reinforced battalion gives the force commander the ability to control the GSR battalion's fires and to shift them quickly to a committed unit if the situation demands a shift.

General Support. General Support is the most centralized of the tactical missions. Battalions assigned the GS mission provide fires to the force as a whole and its own assets, in order. If a DS battalion wanted to augment its fires with a GS unit, the request for fire would be sent to the force artillery headquarters (DIVARTY) which would order the GS unit to fire the mission if DIVARTY deemed it appropriate. General support units provide the least responsive fires to committed brigades but the most responsive to the force commander; hence, the most effective fires for the force as a whole. Typically, the GS mission is performed by divisional and corps MLRS units. These units are positioned by the force artillery headquarters, but since GS and GSR

positions will probably be located in a brigade's area, DIVARTY will usually coordinate their positions with the assistance of the DS battalion. If a conflict for land arises that can not be resolved, the division headquarters may dictate the positioning.

Although units receive a tactical mission, they remain under the command of their parent headquarters, either DIVARTY or a corps artillery brigade. If the operation requires a field artillery unit to perform a mission that does not exactly fit a standard mission, it will be assigned a nonstandard mission. Nonstandard missions may be modified standard missions. As a rule, cannon units will be direct support or reinforcing, and MLRS units will be general support reinforcing or general support.

Battalions supporting corps are either GS or GSR. GSR units augment a DIVARTY's fires when possible. Under the current fielding plan, only MLRS units will remain under corps control. Field Artillery battalions are organized for combat and assigned a standard tactical mission based upon the mission and current situation. The force commander considers the traditional roles and fundamentals of organizing artillery while assigning tactical missions to field artillery units.

The three traditional roles the Field Artillery derived from its mission are close support fires, interdiction fires, and counterfires. The draft FM 6-20 adds deep fires and suppression of enemy air defense (SEAD) fires as roles. How the two new roles relate to the more traditional roles will be discussed below, but

while the Field Artillery's weapons capabilities are expanding its roles and mission remain unchanged. The roles are defined in Joint Publication 1-02 and further described in FM 6-20.

Close supporting fire is defined as "fire placed on enemy troops, weapons, or positions which, because of their proximity, present the most immediate and serious threat to the supported unit."[5] The fires may increase the range at which the supported commander can affect the fight by attacking beyond direct fire range. The ability to shift targets fairly quickly allows commanders to influence the fight more quickly than with most assets. "Close support fires are the primary responsibility of direct support artillery [DS] units."[6] The DS unit may have its fires augmented by up to four other field artillery units with a tactical mission of reinforcing (R).

SEAD is an extension of the close support and counterfire roles. It is directed at targets which pose a "serious threat to the supported unit" and air defense units are considered to be indirect fire systems. Although SEAD is close support, it warrants its own role due to the coordination required within the Army and Marines or with the other services or combined air components. Any field artillery unit, regardless of its tactical mission, may perform SEAD. However, if the mission is conducted by DS or R artillery it should be in support of their supported brigade. If a DS unit fires SEAD, a committed unit loses its responsive fires for a period of time.

Interdiction is defined as "(a)n action to divert, disrupt, delay, or destroy the enemy's surface military potential before it can be used effectively against friendly forces."[7] and deep supporting fire is defined as "(f)ire directed on objectives not in the immediate vicinity of our forces, for neutralizing and destroying enemy reserves and weapons, and interfering with enemy command, supply, communications, and observations."[8] The Army further refines deep attacks as engaging particular functions such as command and control, air defense, or fire support. The role called deep fires is interdiction. The difference between interdiction and deep fires in the draft FM 6-20 is that deep fires attack particular functions and are in support of corps or divisional objectives.[9] These missions could easily fall under interdiction. The definition of close support allows the artillery to engage beyond direct fire range and covers all support to brigades. Since all targets should have a purpose, there appears to be no real difference. Deep fires could be called interdiction or vice versa. Deep fires or interdiction are performed by general support [GS] or general support reinforcing [GSR] units.

Counterfire is defined as "(f)ire intended to destroy or neutralize enemy weapons."[10] Specifically counterfire is directed against indirect-fire systems. The targets are not only weapons but C^2, observation posts, etc. Counterfires are normally controlled by DIVARTY or a reinforcing Field Artillery brigade and performed by GS or GSR units. However, it may be performed by any unit and DS units are sometimes responsible for some level of counterfire such as the

enemy's direct support artillery. Normally, a Q-36 Firefinder radar is attached to the DS battalion to assist in this mission.

The five fundamentals of field artillery organization for combat follow:[11]

- ***A***dequate field artillery support for committed combat units.
- ***W***eight to the main attack in offense or most vulnerable area in defense.
- ***F***acilitate future operations.
- ***I***mmediately available field artillery support for the commander to influence the action.
- ***M***aximum feasible centralized control.

The five are known by the acronym **AWFIM**.

The minimum adequate field artillery support for committed maneuver units according to FM 6-20 is a DS battalion per committed maneuver brigade.[12] The DS battalion's fires may be augmented by a reinforcing or GSR unit. The assignment of a DS battalion provides the most responsive fires to a committed maneuver unit. Normally, the habitually associated artillery battalion of an uncommitted maneuver brigade will be assigned a reinforcing, GSR, or GS mission until the brigade requires support.

The Army Science Board Study learned that the Field Artillery School had a rule of thumb that determined adequate support for the force as a whole to be a field artillery battalion per committed maneuver battalion. The rule did not allocate a field artillery battalion DS to each maneuver battalion. However, the

total field artillery battalions should equal the number of committed maneuver battalions.[13] The objective support structure meets the requirements of this rule since the modernized heavy division has ten ground maneuver battalions, including the divisional cavalry squadron, and there are ten total field artillery battalions in the DIVARTY and two reinforcing corps artillery brigades.

The second fundamental, weight to the main attack in offense or most vulnerable area in defense, is usually achieved by assigning artillery battalions to augment the DS battalion's fires with a reinforcing or GSR mission. A division could also achieve this by planning and executing more GS fires in the main effort's zone than are executed in other zones. The maneuver brigade would not plan or execute the fires. The targets, which could include counterfire, command and control, or following units, would be located by division or higher assets. The GS fires would assist the brigade in accomplishing its mission. The main effort could, also, be allocated more ammunition, especially effective or smart munitions, to help weight it.

To facilitate future operations, commanders can position units in areas where they will operate during another phase, limit ammunition consumption, or assign an on order mission to a unit. For example, if an artillery unit is providing R, GSR, or GS fires, it should be located in an area where the brigade it will be DS to will operate in the future. This should limit the repositioning required when it assumes the DS mission. Limiting this battalion to firing only a set amount of its ammunition during the reinforcing or GSR mission is another example of

facilitating future operations. Assigning this same battalion an on order DS mission allows it to begin planning how it will transition to the DS role and how it will support the brigade when it is committed.

The commander can immediately influence the action with GS and GSR artillery. As a rule, artillery can shift fire to a critical area more quickly than ground maneuver or air elements can move to the area. Field artillery units with GS and GSR missions are responsive to the commander and give him a powerful force with which to influence the action at critical points. Brigade commanders can do the same with DS and reinforcing artillery.

Generally, the more centralized the control of the artillery the more effective will be its fires. Therefore, when organizing for combat, planners must consider the maximum feasible centralized control. When defending, the control should be more centralized so commanders can influence the action quickly and with considerable power. The addition of more MLRS to the GS and GSR missions supports this rule. In the offensive, the control should be more decentralized so fires are more responsive to the units engaged in the close fight. The fielding of howitzers such as PALADIN that shorten emplacement times and are responsive to committed units, supports this tenet. However, the reduction of howitzers in DS battalions does not support the tenet since the volume of fire decreases. The volume of fire available from the various howitzers will be discussed later.

Of the traditional roles of the field artillery, DS and R units usually perform close support. The other roles are usually performed by GS and GSR units. In the past, cannon artillery performed all the tactical missions (DS, R, GS, GSR) for the division. In Europe in December 1987, a committed division could expect support from six cannon battalions and two MLRS batteries (72 155mm SP, 54 8" SP, and 18 MLRS). Since heavy division field artillery support is being focused on two types (155mm and MLRS), it seems that the 155mm howitzers will perform mostly close support (DS and R) while MLRS will perform the other roles in an GS or GSR mission. The objective is to support the division with five cannon battalions and five MLRS battalions (90 155mm SP, and 126 MLRS). The 8" howitzer bridged the gap between DS and GS. While the 8" was not as effective as MLRS in interdiction or counterfire, it could be used to augment 155mm fires in the close fight with effects and characteristics similar to 155mm. The differences in effects and characteristics of cannon and rocket fires will also be examined later.

IV. ANALYSIS

As the Field Artillery reorganizes, it must be able to provide maneuver commanders as much or more support than before. The addition of more MLRS to the force, by itself, shows an increase in combat power for the division and above. However with the reduction of cannon available, FSCOORDs, Fire Support Officers (FSO), and planners must be able to tell maneuver commanders what the difference in volume of fire and effects are and how this

will effect maneuver forces. This will help ensure adequate support is provided and the field artillery is organized effectively and responsively. The capabilities of the newer organizations as compared to the current or recent organization can be determined mathematically, without using classified material.

Equipment.

M109A5 Howitzer.[14] The M109A5 is an upgrade to the M109 self-propelled howitzer fleet that includes the M284 cannon used on PALADIN. The M109A5 has the same rate of fire and ranges as the PALADIN. The howitzer moves and shoots as part of a platoon or battery that must emplace and displace in the same manner as the older versions of the M109 family. The howitzer must be laid for direction and have its location determined. Its fire commands are computed by the platoon fire direction center.

Crew size: nine personnel.

Sustained rate of fire: 1 rd per minute.

Shift time between aimpoints: 1 minute.

Battery emplacement time: 8 minutes

Battery displacement time: 1 minute.

Number of aimpoints per platoon: 4; per battery: 8

Range: 24,000m unassisted; 30,000m assisted.

M109A6 (PALADIN).[15] The PALADIN is an upgrade to the M109 155mm, self-propelled fleet that includes the M284 cannon, The system has on board technical fire direction,[16] and automatic howitzer location capabilities. The

howitzer emplaces itself with the on board systems laying the howitzer for direction and determining location. PALADIN receives tactical fire orders from the platoon or battery headquarters and determines its own firing data.

Crew size: nine personnel.

Sustained rate of fire: 1 rd per minute.

Shift time between aimpoints: 1 minute.

Battery emplacement time: 2 minutes. Two minutes is for a deliberate occupation including inputting site to crest, etc.; a round could actually be fired in 75 seconds under emergency conditions.

Battery displacement time: Immediate. The crew does not have to recover aiming poles or collimator.

Number of aimpoints: per platoon: 3; per battery: 6.

Range: 24,000m unassisted; 30,000m assisted.

CRUSADER.[17] The CRUSADER is a 155mm self-propelled howitzer being developed to replace the M109 family of howitzers in certain units. The howitzer is being developed concurrently with its resupply vehicle (RSV) and the two will make a "system". While firing, the three man howitzer crew will remain in the crew compartment separated from the actual firing mechanism. The RSV is also manned by three personnel but the resupply of the howitzer, like the firing, is automated. CRUSADER is designed to be able to move with maneuver forces. The vehicle itself is designed to be more survivable than the M109 family in addition to being able to move faster and emplace more quickly. Like PALADIN,

CRUSADER emplaces itself with on board systems laying the howitzer for direction and determining location; it receives tactical fire orders from the platoon or battery headquarters and determines its own firing data. In addition, CRUSADER will have a better capability of firing a multiple round simultaneous impact mission (MRSI). This capability means that one CRUSADER can fire four rounds at varying quadrant elevations and have all four impact at the same aimpoint at the same time. It may be able to fire up to eight rounds in this manner. While cannon can do this today, the automated system will enable CRUSADER to perform it more routinely. The automated firing system and cannon have already demonstrated the ability to fire up to twelve rounds per minute.

Crew size: six personnel.

Sustained rate of fire: 4 rounds per minute. The requirements call for 3-6 rounds per minute. Four is about mid-range and seems reasonable. At this rate, the ammunition on CRUSADER (60 rounds) would be expended in fifteen minutes; the ammunition on both CRUSADER and the RSV (up to 200 rounds) would be fired in about 65 minutes.

Shift time between aimpoints: 10 seconds, if the shift is less than 400 mils (22^0); 45 seconds if shift is greater than 400mils.

Battery emplacement time: 45 seconds. The requirements call for a moving CRUSADER to stop and fire the first round in 30-45 seconds.

Battery displacement time: Immediate. The crew does not have to recover aiming poles or collimator.

Number of aimpoints: per platoon: 3; per battery: 6

Range: 27,000m unassisted; 40,000m assisted.

MLRS.[18] MLRS is a medium self-propelled rocket launcher that is capable of firing up to twelve rockets or two ATACMS. Like CRUSADER and PALADIN it lays itself for direction, determines launcher location, and computes its own technical firing solution. As a multiple rocket launcher , MLRS can provide a large volume of effective area fire very quickly. However, its hazard area (danger close is 2000m) limits its usefulness in the close fight. Currently, MLRS can fire a dual-purpose improved conventional munitions (DPICM) rocket or the ATACMS missile. Other munitions being developed for MLRS include MLRS Smart Tactical Rocket (MSTAR) designed to attack soft or hard targets; MLRS Extended Range Rocket (ER-MLRS) to provide DPICM fires to at least 45 kilometers; Extended Range Guided Rocket (ERG) to provide more accurate DPICM fires (within 2-3 mil CEP) to 60 or more kilometers. The DPICM submunition for these rockets is being improved to reduce the dud rate to less than 1 per cent. For ATACMS, Brilliant Anti-armor (BAT) submunitions are being developed. The launcher itself is being modified to shorten its reload time by 50% and its firing time by 70%.[19]

Crew size: three personnel.

Sustained rate of fire: 1-12 rockets per minute at up to six aimpoints. Typically there are twenty to forty-five minutes between missions to account for movement, empty pod download, reload and movement to firing point.[20]

Shift time between aimpoints: 20-45 minutes.

Battery emplacement time: two minutes if on firing point with the launcher, loader module stored; three to six minutes if in hide area.

Battery displacement time: the launcher can move immediately after firing.

Number of aimpoints: up to 6 if firing is to be done in under one minute.

Range: 31,800m using M26 rocket.

Conditions.

- M109A5 battalions are 3X8. The battalion totals twenty-four howitzers with eight per battery and four per platoon. Although these battalions are being converted to eighteen howitzers, twenty-four will be used since this is how the artillery was organized before the current changes.
- PALADIN (M109A6) battalions are 3X6. The battalion totals eighteen howitzers with six per battery and three per platoon.
- CRUSADER battalions are 3X6. The battalion totals eighteen howitzers with six per battery and three per platoon.
- MLRS batteries are 9 launchers. They may fire a single launcher (12 rockets), a platoon (36 rockets), or battery (108 rockets) per mission.

- The crews of all howitzers are trained to standard.
- The weapons and crews are capable of firing, shifting fire, emplacing and, displacing within standard.
- Target locations for missions are accurate.
- All 155mm howitzers are capable of firing the same munitions.
- The enemy operates similar to the enemy described in Opposing Forces Battle Book published by the School for Command Preparation.
- Operations are conducted in daytime. The daytime emplacement standard for the M109A5 is eight minutes. The nighttime standard is fifteen minutes.
- Bursting radius for 155mm is 50m, the high explosive radius, unless noted otherwise.

COMPARISON.

M109A5 (3X8) Vs PALADIN (3X6).

The M109A5 and PALADIN have the same cannon and are capable of firing the same munitions at the same ranges. The major differences between systems are PALADIN's capability to lay itself for direction and determine its location. The major difference between organizations is the twenty-four howitzers in a 3X8 battalion versus eighteen howitzers in the 3X6 battalion. The reduction of howitzers in all artillery battalions will allow fielding of PALADIN to all active duty self-propelled 155mm battalions and early-deploying National Guard

battalions. Additionally, the reduction frees personnel to be used in the modernized heavy division's command and attack battalions.

An eight-howitzer M109A5 battery can fire eight rounds per minute or a total of 480 per hour. In this example, the battery did not move either because the situation would not allow it to move, such as an intense battle (slugfest), or the counterfire threat was negligible. The six-howitzer PALADIN battery can only fire six rounds per minute or 360 rounds per hour. The PALADIN fires one fourth less rounds than the eight howitzer battery because it has one fourth less howitzers. If the battlefield is static, this difference is considerable. However, the more fluid the battlefield the better PALADIN performs with respect to the M109A5. The changeover point when the M109A5 battery provides a greater volume of fire than the PALADIN battery is twenty-nine minutes in position (See Appendix III). This is based on emplacement and displacement times and rates of fire. If the unit can stay in position more than twenty-nine minutes, the M109A5 battery or battalion provides a greater volume of fire than PALADIN.

Since the PALADIN battery can emplace six minutes quicker than the M109A5 battery and displace one minute faster, it can fire seven minutes longer from a position than the M109A5. This seven minutes equals forty-two rounds. However, the two extra howitzers negate this volume in twenty-one minutes after they begin to shoot i.e. at minute 29. It requires thirty-two minutes if PALADIN emplaces in one minute instead of two , an emergency occupation versus a deliberate occupation. At night, an M109A5 battery is allowed fifteen minutes by

the mission training plan to emplace, increasing PALADIN's initial advantage over the M109A5. Therefore on a fluid battlefield, such as an attack, with the artillery remaining in position for less than half an hour, PALADIN provides a greater volume of fire.

PALADIN could make up some of its shortfall by firing more rounds per tube per target. Although the volume may be equal, the effects may not be equal due to the longer time required to fire.[21] This may result in less total targets being fired or in delays while desired effects are being achieved.

M109A5 (3X8) Vs CRUSADER (3X6).

In their article "Crusader: Force XXI's Top Gun" Majors Steven Lopez and Fred Coppola state, "MRSI will allow Crusader to achieve the same effects as a battery of conventional howitzers."[22] Instead of equating a CRUSADER to an M109A5 or PALADIN battery, equating a six-tube CRUSADER battery to a 24 howitzer battalion of PALADIN or M109A5 is more realistic. This is still a significant increase in potential firepower. Their article is based on the ability of one CRUSADER to have four to eight rounds impact at the same aimpoint at the same time. The ability to achieve this is based on range to target, time of flight, and the sustained rate of fire. Four rounds impacting at the same time is probably more realistic than eight rounds for most ranges. With a sustained rate of fire of four rounds per minute; to achieve an eight round MRSI the first round fired would require a time of flight at least two minutes longer than the last round fired.

Another reason one howitzer does not equate to eight is that MRSI is fired at one aimpoint while a battery of eight howitzers is fired at eight aimpoints (See Piece to point data versus piece to center of target data below and Appendix IV). This gives the eight howitzer battery a larger effective area, and most artillery targets will be area targets. However, a battery of six CRUSADER can have six aimpoints and cover an area similar to the battalion massed fires of the M109A5 with more density in some areas and less in others. The battery can also fire a four round MRSI to have twenty-four rounds impact at the same time. The same volume as a massed M109A5 battalion.

While it may be tempting and on some occasions appropriate to have CRUSADER fire as single howitzers or platoons because of the large volume they can achieve, CRUSADER should normally be fired as batteries for better effectiveness and command and control. Battery fires are more effective because a larger volume of fire impacts more quickly and the area covered is larger. A single howitzer or platoon can not achieve the same area or volume in the same time as the battery. Additionally when firing battery missions, the battalion would only have to control three batteries firing the equivalent of three battalion missions simultaneously, in today's standard. Reinforcing fires would add to the amount of fires controlled. With single howitzer or platoon missions, the battalion would control, potentially, eighteen separate missions. The focus of fires could quickly shift from the commander's intent and critical areas.

CRUSADER's greater range, 40 kilometers versus 30 kilometers for the M109 series, will allow engagement of the enemy for an additional ten kilometers, or about thirty minutes longer, before the enemy can engage friendly maneuver forces. This equates to three more targets per CRUSADER battery or nine for the battalion as opposed to the standard M109A5 battalion.[23] If a motorized rifle platoon were destroyed each mission, the range increase equates to three more companies or an additional battalion of maneuver forces that would not engage friendly forces. In addition to physical damage, the enemy will suffer greater moral and cybernetic damage. The thirty minutes of additional fires will cause greater disruption of his force reducing his ability to effect friendly maneuver forces. According to some simulations, maneuver could face 40% fewer direct fire engagements.[24]

To utilize the greater range of CRUSADER, brigades and DS battalions will have to use available resources more efficiently than today and they will probably have to be augmented from higher. Even with the shorter ranges available today, it is difficult to put "eyes" on every planned target.[25] If a planned target does not have an observer to trigger it, the target is meaningless. One Table of Organization and Equipment shows a reduction of FISTs. This may effect the brigade's ability to effectively use the added range of CRUSADER.

CRUSADER may range beyond the brigade's forward boundary. How could these fires be controlled to ensure they are effective? Conceivably, CRUSADER units could be GS to division and become DS to a brigade as the

enemy nears the brigade's zone. If coordinated, this could be done without much confusion. However, fires would be less responsive if the brigade should need fires before the battalion has received its change of mission. The cannon battalions could remain DS and receive missions from the force artillery headquarters, similar to GS, that they would fire if they did not receive missions from the supported brigade or their own assets. Leaving the battalion DS would seem more appropriate since the brigade could receive responsive fires if needed and, history has shown that committed brigades require a DS artillery battalion. Additionally, if the deeper targets supported the brigade's fight directly, the battalion would be providing close support. This could be accomplished if the brigade FSOs coordinated with division FSE.

If logistic assets are not available to meet CRUSADER's greater capabilities, CRUSADER's advantage over PALADIN and the M109A5 will be limited. However, CRUSADER should still outperform the other two. CRUSADER could partially eliminate an ammunition haul problem by having a stockage on the ground that the resupply vehicle could reload as opposed to bringing additional trucks forward. This would be similar to PALADIN or the M109A5 firing initial missions from ammunition stored on the ground.

When fielded, CRUSADER will bring more firepower and survivability to the battlefield than PALADIN or the M109A5. A DS CRUSADER battalion will be roughly equivalent to three PALADIN or M109A5 battalions, giving the brigade considerably more power. With its additional range, CRUSADER should reduce

the amount of enemy the brigade has to fight compared to the amount fought with either PALADIN or M109A5 in DS. CRUSADER will ease the problem of maneuver forces having to wait on the artillery since it is being designed to be as mobile as the maneuver forces.

Piece to point data versus piece to center of target data.

The M109A5 howitzers have their fire commands computed by the platoon FDC. The fire direction computer uses a battery computer system (BCS) with a default circular sheaf of 100 meter radius. The howitzers are given aimpoints 50 meters from the center at equal angles starting at grid north. The number of aimpoints equals the number of howitzers whose firing data is determined by the computer. For example, in a 3X8 battalion conducting platoon operations, the platoon fire direction computer would determine one aimpoint for each of its four howitzers, a total of four aimpoints per platoon. All six platoon FDCs would determine the first aimpoint due north of the target by 50m, the second aimpoint due east, the third aimpoint due south, and the fourth aimpoint due west (see Appendix IV). If the battalion massed on the target, there would be six howitzers, one per platoon, firing on each aimpoint. The data computed, however, would be from each howitzer's location to the assigned aimpoint. If the battalion was firing battery level missions, only one computer per battery computing firing data for all eight howitzers, the battalion would fire three howitzers due north, three northeast, three due east, three southeast, three south, three southwest, three west and three northwest for a total of eight

aimpoints. In the first example of four aimpoints, the circular sheaf would resemble a diamond covering an area greater than 20,000 square meters but less than 31,000 square meters. With eight aimpoints, the area covered is more circular and approaches 31,000 square meter area. As the number of aimpoints increases to eight, not only is the area of coverage increased but the density of submunitions or shrapnel increases due to overlapping of effects. For a six howitzer battery, the area of coverage is almost the same as eight howitzers, close to 31,000 square meters, but the density of submunitions or shrapnel is lower since two less howitzers are firing.

PALADIN's technical fire direction is determined by the on board computer. The default for PALADIN is firing data computed from the howitzer to the center of target, a converged sheaf. With a bursting radius of 50m, the area covered is 7,900 square meters (See Appendix IV). While the actual area covered will vary based on the natural dispersion of the rounds, the area covered by a converged sheaf is the same no matter how many howitzers fire. However, the majority of targets should still be area targets such as artillery batteries or maneuver companies, not point targets such as individual vehicles or bunkers. Potential enemy maneuver companies and artillery batteries will typically cover frontages of 300 meters or more[26]. Greater effects will be achieved using the 100m radius circle as the default sheaf. PALADIN can fire an open sheaf similar to the BCS default. This would have the on board computer determine an aimpoint similar to the M109A5. If PALADIN units fire open sheafs, the best

solution would be to fire as six howitzer batteries since the area covered, about 31,000 square meters, and effects would be similar to eight howitzers firing. For CRUSADER with a faster rate of fire, the effects should be greater although the area of coverage would be the same. If PALADIN fires by platoon, the area covered is roughly a triangle with an area of about 18,900 square meters. The area covered by a three howitzer platoon is roughly one fourth smaller than the area covered by four or more howitzers.

If the target is a point target or densely packed, the observer or fire direction officer could direct that a converged sheaf be fired. For a converged sheaf, the computer determines piece to center of target data. Every howitzer will fire at the same aimpoint producing a dense concentration of submunitions or shrapnel. Likewise data can be determined for targets with irregular shapes or a radius greater than 100 meters.

SADARM.[27] The sense and destroy armor (SADARM) round will add a new dimension to fire support. The round is in limited production and should be fielded in 1999. SADARM is a fire and forget smart munition that is delivered to the area by 155mm cannon. The round contains two submunitions that attack the tops of vehicles located within their footprint (about 120 feet in radius). The submunitions' sensors guide them onto targets. Although the round was designed for counterbattery missions and against other light armor, it is just as capable of killing tanks or infantry fighting vehicles. Although SADARM was designed for stationary targets, it should be effective against moving targets as

long as the target does not leave SADARM's footprint. It will, however, experience the same problems all artillery has engaging moving targets. The observer must trigger the mission at the correct time to be effective.

The use of multiple aimpoints to increase area of coverage is just as critical with SADARM as with other munitions. If all SADARM are fired at one aimpoint, a converged sheaf, the submunitions will attack only vehicles in a circle of about 100 meters radius. If vehicles are 50 meters apart, there would be only two or three vehicles in the area covered; however, there would be up to sixteen submunitions if an M109A5 battery was fired. If SADARM is spread throughout the target area, it will identify and attack more targets. SADARM could be spread too thinly and its targets too dispersed to have an immediate effect on the battle; therefore, an area similar to the default for M109A5 platoons may be most effective. Using this sheaf, two four howitzer platoons firing one volley each at a different aimpoint, about 80 meters apart, can cover an area roughly 350m by 350m with sixteen submunitions. A section more than 200m by 200m of the total coverage area falls within the footprint of at least three submunitions. The coverage area is roughly equivalent to a battery position, and platoon or company frontage. This pattern is called the "double diamond" and is formed by using the BCS solution for two target grids 80m apart.

In 3X6 battalions, the "double diamond" pattern will be replaced by a pattern of two triangles that covers an area about 330m by 330m. The area falling within the footprint of three or more submunitions is also reduced.

CRUSADER could form the "double diamond" pattern in under a minute using just two howitzers instead of two platoons. PALADIN firing a six gun battery could cover the same area in one minute with four howitzers firing one round and two howitzers firing two rounds.

During various simulations, SADARM was able to achieve at least 16 per cent greater effects while firing about 80 per cent less total rounds than DPICM. Using the "double diamond" pattern, SADARM is achieving kills on five or six vehicles out of eight in the area. Five or six is not the number of submunitions that hit, but the number of vehicles killed. A reduction of a fourth of the submunitions in the area will probably result in one or two less kills. SADARM can be fired from any 155mm howitzer; the range achieved by PALADIN/M109A5 is 22,500m, CRUSADER will achieve about 27,000m.

A technique for employing SADARM against a moving enemy is to fire a "double diamond", then allow the enemy to move out of the immediate area. After the enemy has moved, reengage with SADARM. This clears the area of destroyed vehicles allowing the following SADARM to engage operative vehicles. For example, a brigade in the defense can expect the artillery to engage the enemy in one area about every 2,700m with five or seven battalion volleys of DPICM. With DPICM, the enemy is engaged in an area of a circle with 100m radius. With SADARM, the six platoons of a battalion could engage the enemy across a frontage of more than two kilometers. Of course, the targets do not have to be continuous but along likely avenues. However, the number of

observers required to trigger the fires will vary. Instead of firing five to seven volleys, the howitzers would fire one volley of SADARM allowing the enemy to move out of the immediate area. The battalion could reengage the target at 330m instead of 2,700m, theoretically. However, 500m to one kilometer may be a more realistic distance.[28] In this example, the 3X8 M109A5 battalion delivers more volume than PALADIN but PALADIN's mobility may allow it to fire more.

Continuing the example, PALADIN should be able to move about a kilometer and emplace in six minutes being out of action for two kilometers of the enemy's movement. If the battalion moves by batteries, the rest of the battalion can still engage at less of a volume. CRUSADER allows one platoon to fire all six platoon targets in about a minute and a half and move. While the one platoon fires all six targets, the others could be moving or waiting to fire their series of six.[29] In this case CRUSADER will provide the volume of the 3X8 battalion with the survivability of PALADIN.

The addition of SADARM will improve the effectiveness of all three howitzers. SADARM will improve the survivability of all 155mm howitzers in a high counterbattery threat area because greater effects can be achieved with less firing. Enemy counterbattery radars, flash, and sound ranging equipment will have less opportunity to identify the firing unit. The requirement for less firing allows time for more missions or moving to new positions before counterfire impacts. With less rounds being fired, the logistic burden of field artillery ammunition resupply will be eased. However, the reduction may not be as

drastic as the 80% fewer rounds would indicate. The actual burden will depend on the amount of SADARM available and fired compared to other munitions.

Rocket Fires Vs. Cannon Fires.

The large danger close range for MLRS (2000m) limits its use as a DS artillery system. It is further limited by its reaction time, although the improved MLRS (M270A1) will be more responsive. However, MLRS can deliver large volumes of fires quickly to augment DS fires. MLRS can fire at enemy artillery elements supporting the close fight so friendly DS artillery will not have to shift fires. MLRS can also fire against large formations that are stopped or moving so the fires can be triggered correctly.

One MLRS M26 rocket dispenses 644 submunitions. These submunitions are similar to the 155mm DPICM but can penetrate up to four inches of armor. DPICM from 155mm can penetrate 2.75 inches.[30] In absolute numbers, a launcher firing twelve rockets delivers 7,728 submunitions. If MLRS is fired at the same aimpoints as the 155mm battalion, the radius of the circle would increase about another 50m due to the bursting radius. A 155mm DPICM round has 88 submunitions. An eighteen-howitzer battalion, has to fire five volleys to deliver 7,920 submunitions, about two 155mm DPICM rounds extra. With one launcher delivering as much power and more penetrating power than a battalion five of 155mm, it is clear that MLRS can provide assistance to maneuver when a punch is needed quickly.

There are some drawbacks, however. After firing, the launcher will be out of action to resupply for twenty or more minutes. The targets must be thoroughly coordinated with maneuver because of the dud rate for the submunitions and danger close distance. Future ammunition should reduce the dud rate considerably. The required amount of time to resupply, hazard area, and possibility of duds limit MLRS capability as a DS system.

There are other reasons that MLRS is not as suitable as cannon artillery for the DS mission. MLRS units do not have organic fire support personnel to support maneuver companies, battalions or brigades. If the brigade has fire support personnel attached from the habitually associated DS battalion this limits but does not prevent a DS mission. MLRS ammunition does not include all the ammunition types available to 155mm such as smoke and illumination. The required logistical support would require shifting large assets in the support community for maintenance and ammunition resupply but again this does not make it impossible for MLRS to be DS only more difficult.

Currently, counterfire is of great importance to most maneuver commanders. Counterfire will increase in importance as other nations develop munitions similar to SADARM. Since field artillery is relatively cheap, many nations rely heavily on artillery. SADARM will increase their ability to destroy heavier forces. The United States may face armies equipped with large amounts of SADARM or other smart munitions, posing a threat to maneuver forces and

their artillery support. Immediate destruction of enemy artillery will become even more critical to force protection and mission accomplishment.

Two possibilities exist for counterfire. DIVARTY is responsible for all counterfire. With the amount of MLRS available this should be possible. In this case, the Q-36 normally attached to the DS battalion would require a direct link to the counterfire headquarters. DIVARTY may even emplace and control all radars to ensure adequate coverage. Of course, if DIVARTY became overloaded with targets, DS or reinforcing fire could attack counterfire targets if the brigade commander desired. They may also attack if brigade assets spot enemy artillery. In the second case, the DS battalion would be responsible for the enemy direct support artillery in its area. This battalion could receive a GSR MLRS battery that would fire the counterfire required by the brigade. The better solution is the first case, which allows the DS battalion to concentrate on the close fight.

National Guard Support to the Brigade.

Based on history and the Army Science Board study, National Guard corps artillery units can support active brigades and divisions. Corps artillery units focus training on howitzer and launcher crew drill, command and control, and sustaining tasks. The units do not have to train the additional fire support tasks associated with DS artillery. Integrating fire support is considered more difficult to train. Two reserve component field artillery brigades were able to

deploy and participate in Desert Storm. The required tasks can be trained during drills with a minimum of train up required.

V. Conclusions

Brigade, division, and corps commanders can expect more support from the Field Artillery as we enter the twenty-first century. The addition of the second corps artillery brigade as reinforcing to the division and the reorganization of the corps brigades to two MLRS battalions and a 155mm self-propelled battalion will give the division commander tremendous combat power compared to that at the end of the Cold War. When CRUSADER is fielded, the maneuver brigade commander can expect greater effects from the DS field artillery support than from a DS and reinforcing battalion today. However, the reduction of DS battalions from twenty-four to eighteen howitzers will cause volume of fire and area coverage, if firing by platoon, to decrease until CRUSADER is fielded. This is particularly true in a static environment. The fielding of PALADIN will actually increase volume of fire and shorten response time in a more fluid environment.

The optimum would be to field PALADIN in twenty-four howitzer battalions. This would guarantee the battalion provides the same volume of fire as before with improved mobility. However, this would not create the manpower necessary for the command and attack battalions, nor would there be enough PALADIN to re-equip all the early-deploying National Guard battalions. In areas where US forces are faced with an immediate artillery threat, such as Korea, perhaps the forward deployed cannon battalions should field twenty-four

howitzers until CRUSADER is operational. The fielding of SADARM will reduce the shortfall and should greatly increase the effectiveness of field artillery fires on heavy forces while lessening the strain on the logistics system. The brigade commander will experience some advantages and disadvantages until CRUSADER is fielded.

The additional rocket launchers provide a potent deep fire and counterfire ability to division and corps. Although of limited use in the close fight, MLRS can quickly add a large volume of fire to the brigade's fight. Additionally, MLRS should be able to handle the counterfire fight, freeing DS artillery to support committed maneuver units.

The objective for field artillery force structure and organization will provide the support required in the future, Overall, maneuver should face less enemy, receive more responsive and more effective fires than under current conditions allowing maneuver to conduct decisive operations and achieve victory more easily.

APPENDIX I

INHERENT RESPONSIBILITIES OF FIELD ARTILLERY MISSIONS (FM 6-20)

An FA Unit With A Mission of-	Direct Support	Reinforcing	General Support Reinforcing	General Support
Answers calls for fire in priority from	1. Supported unit 2. Own obserevers[1] 3. Force FA HQ	1. Reinforced unit 2. Own obserevers[1] 3. Force FA HQ	1. Force FA HQ 2. Reinforced unit 3. Own obserevers[1]	1. Force FA HQ 2. Own obserevers[1]
Has as its zone of fire	Zone of action of supported unit	Zone of fire of reinforced FA unit	Zone of action of supported unit to include zone of fire of reinforced FA unit	Zone of action of supported unit
Furnishes fire support team (FIST/FSS)[2]	Provides temporary replacements for casualty losses as required	No requirement	No requirement	No requirement
Furnishes liaison officer	No requirement	To reinforced FA unit HQ	To reinforced FA unit HQ	No requirement
Establishes communications with -	Company FSOs, FSOs, and supported maneuver unit HQ	Reinforced FA unit HQ	Reinforced FA unit HQ	No requirement
Is positioned by -	DS FA unit commander or as ordered by force FA HQ	Reinforced FA unit or as ordered by force FA HQ	Force FA HQ or reinforced unit if approved by force FA HQ	Force FA HQ
Has its fires planned by	Develops own fire plans	Reinforced FA unit HQ	Force FA HQ	Force FA HQ

[1] Includes all target acquisition means not deployed with supported unit (radar, aerial observers, survey parties, etc.).

[2] A fire support section (FSS) for each maneuver brigade/battalion/squadron and one FIST with each maneuver company/ ground cavalry troop are trained and deployed by the FA unit authorized these assets by TOE. After deployment, FISTs and FSSs remain with the supported maneuver unit throughout the conflict.

APPENDIX II

Weapons Capabilities Used for Report

Type of Howitzer	M109A5	PALADIN	CRUSADER	MLRS
Crew Size	9	9	6	3
Sustained ROF (rds/min)	1	1	4	up to 12 at six aimpoints; expect at least twenty minutes between missions
Shift Time Between Aimpoints	1 minute	1 minute	10 seconds if less than 400 mils; 45 seconds if greater than 400 mils	10 seconds
Number of Aimpoints Per Platoon/Launcher	4	3	3	up to 6
Battery Emplacement Time	8 minutes (day)	2 minutes (deliberate)	45 seconds	2 minutes if on firing point with LLM stowed
Battery Displacement Time	1 minute	<1 minute; howitzer can move as soon as round is fired	<1 minute; howitzer can move as soon as round is fired	<1 minute; launcher can move as soon as round is fired
Range	24,000m	24,00m	27,000m (SADARM)	31,800m (M26)
Range (Assisted)	30,000m	30,000	40,000m	45,000m (ER-MLRS 60,000m (ERG)

APPENDIX III

Volume of Fire Capabilities

Start of Minute	M109A5 Battery (8 Howitzers)	M109A5 Battalion (24 Howitzers)	PALADIN Battery (6 Howitzers)	PALADIN Battalion (18 Howitzers)	CRUSADER Battery (6 Howitzers)
0					
1					24
2			6	18	48
3			12	36	72
4			18	54	96
5			24	72	120
6			30	90	144
7			36	108	168
8			42	126	192
9	8	24	48	144	216
10	16	48	54	162	240
11	24	72	60	180	264
12	32	96	66	198	288
13	40	120	72	216	312
14	48	144	78	234	336
15	56	168	84	252	360
16	64	192	90	270	384
17	72	216	96	288	408
18	80	240	102	306	432
19	88	264	108	324	456
20	96	288	114	342	480
21	104	312	120	360	504
22	112	336	126	378	528
23	120	360	132	396	552
24	128	384	138	414	576
25	136	408	144	432	600
26	144	432	150	450	624
27	152	456	156	468	648
28	160	480	162	486	672
29	**168**	**504**	**168**	**504**	**696**
30	176	528	174	522	720
31	184	552	180	540	744
32	192	576	186	558	768
33	200	600	192	576	792

Table does not include travel time between positions.

The nonfiring times includes displacement time from the previous position and emplacement time at the current position.

APPENDIX IV

Sheafs and Area Coverage

1. *One Howitzer Mission or Converged Sheaf.* If one howitzer fires a mission or if a converged sheaf is used for more than one howitzer, one aimpoint is determined. The aimpoint is the center of the target. With a bursting radius of 50 meters, the area covered by one round or a converged sheaf is about 7,900 square meters. The area is determined by using the formula for the area of a circle. The area of a circle equals PI times the radius squared.

$$PI = 3.1416$$
$$R = 50m$$
$$Area = 3.1416 \times (50)^2$$
$$7{,}854\ m^2 = 3.1416 \times (2500)$$

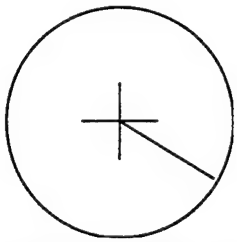

Figure 1. One howitzer or multiple howitzers firing a converged sheaf.

2. *Two Howitzer Sheaf.* When two howitzers fire a mission, one aimpoint is placed 50 meters grid north of the target and one is placed 50 meters grid south of the target. The area covered by two howitzers is twice the area covered by one or a converged sheaf.

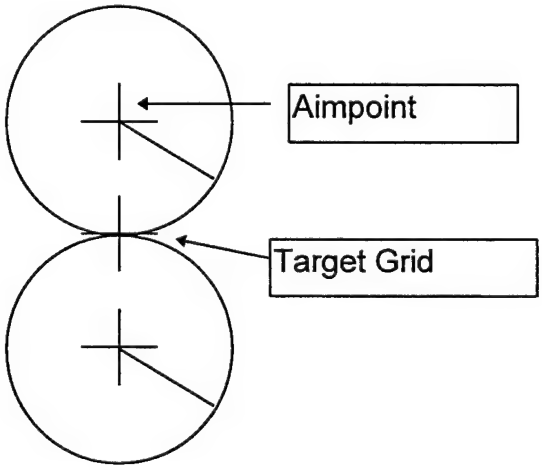

Figure 2. Two howitzer sheaf.

3. *Three howitzer platoon sheaf.* The sheaf for a three howitzer platoon resembles a triangle 180 meter in height and 210 at the base. The first aimpoint is grid north; the second is at 120 degrees; and the third is at 240 degrees. Effects begin to overlap using a three howitzer sheaf. The area is less than the area of a triangle due to the circular nature of the effects area of ecah round. The area of a triangle equals 1/2 times the base times the height.

$$1/2 \text{ X } 210\text{m X } 180\text{m} = 18{,}900\text{m}^2$$

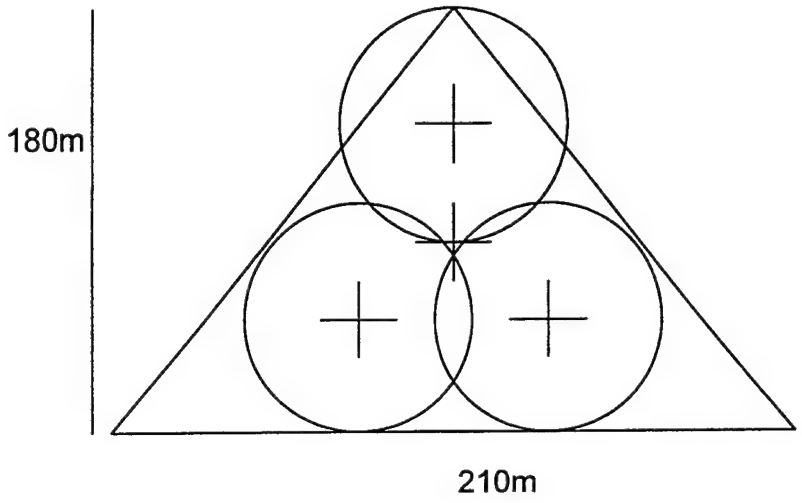

Figure 3. Three howitzer platoon sheaf.

4. *Four howitzer platoon.* The sheaf of a four howitzer platoon resembles a diamond 200m in width and 200m in height. The first aimpoint is grid north; the secod is grid east; the third is grid south; and, the fourth is grid west. The area covered is greater than 20,000 m^2 but less than 31,000 m^2.

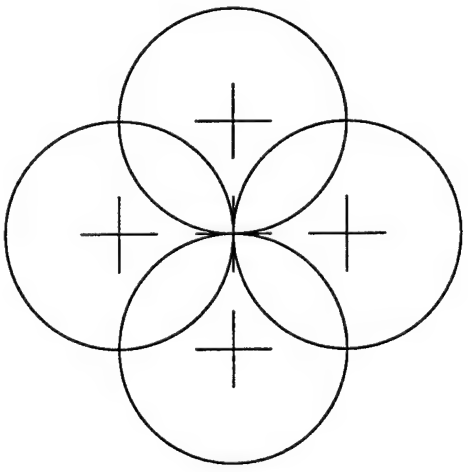

Figure 4. Four howitzer platoon sheaf.

5. *Six howitzer battery sheaf.* A six howitzer battery sheaf resembles a circle with a radius of 100 m and covers an area of about 31,000 m^2.

$$3.1416 \text{ X } (100)^2 = 31{,}416 \text{ or about } 31{,}000 \text{ } m^2$$

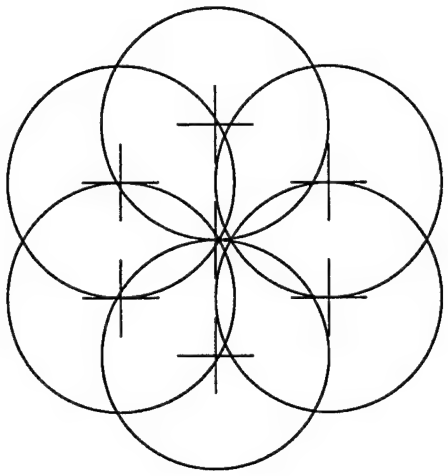

Figure 6. Six howitzer battery sheaf.

6. *Eight howitzer battery sheaf.* The sheaf of an eight howitzer battery resembles a circle of radius 100m and covers about 31,000m^2. This sheaf covers slightly more area than the six howitzer sheaf and has more overlapping effects.

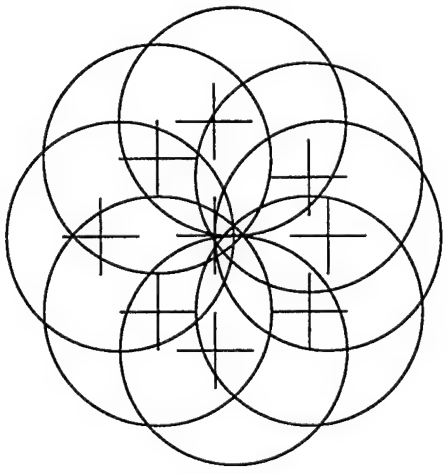

Figure 6. Eight howitzer battery sheaf.

ENDNOTES

[1] Final Draft, FM 6-20, MCWP 3-1.6.1, Doctrine for Fire Support, 21 June 1996, pg. 4-15

[2] Rigby, MG Randall L., Field Artillery, HQDA PB6-96-6, "Mapping the Future: State of the Branch 1996", November-December 1996, pg. 1.

[3] In December 1987, there were 221 MTOE Field Artillery battalions in the total army (98 were active duty, 105 were National Guard, and 18 were Army Reserve); in December 1996, 9 years later, there was 139 (51 were active duty, and 88 were National Guard). This information was gathered from the December 1987 PB6-87-6(Test) Field Artillery "Redbook" and the November-December 1996, PB6-96-6, Field Artillery, "Redbook".

[4] Currently, there are no USAR MTOE Field Artillery units, only training units.

[5] Joint Pub 1-02, Department of Defense Dictionary of Military and Associated Terms, 23 March 1994, pg. 74.

[6]Final Draft, FM 6-20, MCWP 3-1.6.1, Doctrine for Fire Support, 21 June 1996, pg. 4-16.

[7] Joint Pub 1-02, Department of Defense Dictionary of Military and Associated Terms, 23 March 1994, pg. 209.

[8]ibid. pg. 116.

[9]Final Draft, FM 6-20, MCWP 3-1.6.1, Doctrine for Fire Support, 21 June 1996, pg. 4-16.

[10] Joint Pub 1-02, Department of Defense Dictionary of Military and Associated Terms, 23 March 1994, pg. 101.

[11]The following list of the fundamentals of organizing field artillery for combat are taken directly from the reference. They are, however, known verbatim by most artillery officers. FM 6-20, Fire Support in the AirLand Battle, 17 May 1988, pg. 2-10.

[12] FM 6-20, Fire Support in the AirLand Battle, 17 May 1988, pg..

[13]Army Science Board, Innovations in Artillery Force Structure, Ad Hoc Study Final Report, October 1995, pg. 11.

[14]The data for the M109A5 was gathered from Weapon Systems United States Army 1997, and ARTEP 6-037-30 MTP, Mission Training Plan for the Cannon Firing Battery 155mm, Self Propelled, 28 March 1989.

[15]The data for the M109A6 (PALADIN) was gathered from Weapon Systems United States Army 1997, Lees, LTC Mark, phone interview, 31 October 1997, and Gilbert, SSG Ronald, phone interview, 28 October 1997. LTC Lees had served as XO of a PALADIN battalion and SFC Gilbert is a member of the PALADIN NET Team.

[16] Technical fire direction determines the fire commands for the howitzer. It is determined by the on board computer for PALADIN and CRUSADER. For the M109A5, it is determined in the platoon or battery FDC and transmitted to the howitzers. Tactical fire direction determines how best to attack the target. It determines the fire order. The fire order is transmitted to the technical fire direction computer to determine fire commands.

[17]The data for the CRUSADER was gathered from Weapon Systems United States Army 1997, and Brown, MAJ Reginald, email response to questions, 28 October 1997. MAJ Brown serves in TRADOC System Manager - Cannon (TSM-Cannon).

[18]The data for the MLRS was gathered from Weapon Systems United States Army 1997, and FM 6-60, Multiple Launch Rocket System (MLRS) Operations, 23 April 1996.
[19]The information on the time improvement for firing and reloading were contained in Weapon Systems, United States Army 1997.

[20] FM 6-60, Multiple Launch Rocket System (MLRS) Operations, 23 April 1996, pg. 5-12, Headquarters, Department of the Army, Washington, DC.

[21] A general rule for artillery effects states that greater effects are achieved when higher volumes of fire surprise the enemy before he can react. If the same volume is fired over a longer period, the effects are reduced due to enemy reaction.

[22] Lopez, MAJ Steven, and Coppola, MAJ Fred, Military Review, Volume LXXV, No 6, "Crusader: Force XXI's Top Gun", November-December 1995, pg. 65.

[23] Based on being able to engage the enemy every 2,700m. This is based on the enemy moving at 20 kilometers an hour (a kilometer every three minutes), and a shift time of one minute for the howitzer (the enemy travels 330m in one minute). If firing seven volleys of HE or DPICM in seven minutes, the enemy should travel only 2,330m. However, through experience FSOs know to add the

additional distance because of the rate of fire, and coordination required to engage the next target and ensure the batteries are ready. Theoretically, each battery could fire at four more targets, shifting every 2,500m, for a total of twelve.

[24] Lopez, MAJ Steven, and Coppola, MAJ Fred, Military Review, Volume LXXV, No 6, "Crusader: Force XXI's Top Gun", November-December 1995, pg. 64.

[25] Eyes includes, humans (FISTs, maneuver, scouts, etc.), counterfire radars, ground surveillance radars, targeting UAVs, JSTARs, etc.

[26]Opposing Forces Battle Book, School for Command Preparation, 1 January 1997, US Army Command and General Staff College. pg. MAN-25-27 AND FS-9.

[27]Cuff, COL Michael V., phone interview, 28 October 1997, and Brown, Douglas B., phone interview, 30 October 1997. COL Cuff is the Director of TSM-Cannon and Mr. Brown is his deputy.

[28] This is based on the same conditions as the endnote 14. The same factors as above make 500m to one kilometer more realistic for SADARM than the theoretical 330m.

[29] CRUSADER could put one howitzer of its three howitzer platoon on the four aimpoints fired by the M109A5 platoon. In forty seconds, three platoon size targets would be fired. The three CRUSADER would then shift to the other three platoon targets and do the same. In about a minute and a half, the same volume of fire and aimpoints would be engaged by the CRUSADER platoon as by the 3X8 battalion. The Crusader could move while the M109A5 battalion would have to stay to fire the next group.

[30]TM 43-0001-28, Artillery Ammunition Guns, Howitzers, Mortars, Recoilless Rifles, Grenade Launchers, and Artillery Fuzes (Federal Supply Class 1310, 1315, 1320, 1390), April 1977 with Change 16 24 July 1987, pg. 8-39.

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